Taxonomy, ecology and conservation of the cave-dwelling spider Histopona palaeolithica, with the description of H. petrovi sp. nov. (Araneae: Agelenidae)

FEATURED ARTICLE

Running head: MAMMOLA ET AL. – REMARKS ON TWO CAVE DWELLING *HISTOPONA*

Taxonomy, ecology and conservation of the cave-dwelling spider *Histopona palaeolithica*, with the description of *H. petrovi* sp. nov. (Araneae: Agelenidae)

Stefano Mammola[1,2], Filippo Milano[1,2], Marco Isaia[1,2,*]

[1] Department of Life Sciences and Systems Biology, University of Turin, Torino, Italy

[2] IUCN SSC Spider & Scorpion Specialist Group, Torino, Italy

*Corresponding author: marco.isaia@unito.it

Abstract. The spider genus *Histopona* (Araneae: Agelenidae) includes several species exhibiting preference for the subterranean conditions, being occasionally or exclusively found in caves, crevices and similar habitats. Within the genus, the species displaying the highest level of subterranean adaptation is possibly *H. palaeolithica* Brignoli, 1971. This species was described based on a female collected in 1967 in a cave on the Western Ligurian shore (Italy), and never recorded thereafter. Our recent biospeleological surveys at the type locality failed in recovering the species, possibly because of the involvement of the cave in the expansion works of a large quarry. However, we found a new population in a cave opening, a few hundred meters away from the type locality. As a result of this finding, we provide the first description of the male, as well as a re-description of the female. We also describe a new species of *Histopona* based on a female specimen that was collected in a cave in Montenegro, and that was previously attributed to *H. palaeolithica.* In light of the rarity of these specialized stenoendemic species, we provide general information on their ecology and conservation status, as well as information useful for assessing their extinction risk based on IUCN guidelines.

Keywords: Endemism, Extinction risk, Mediterranean, Subterranean Fauna, Systematics

The genus *Histopona* Thorell, 1869 (Araneae: Agelenidae) currently includes 22 species primarily distributed in the Central-Eastern Mediterranean basin (World Spider Catalog—WSC 2019). According to the latest overview on the European subterranean spiders (Mammola et al. 2018), at least 15 of these species exhibit preference for the subterranean conditions, being occasionally or exclusively found in caves, crevices and similar habitats (Brignoli 1971, 1972, 1977a, 1977b; Deeleman-Reinhold 1983; Deltshev 1978; Gasparo 2005; Deltshev & Petrov 2008; Bolzern et al. 2013). Such ecological preference parallels the appearance of morphological adaptations to the subterranean conditions (troglomorphism; Christiansen 2012), which in *Histopona* primarily pertains to size, loss of pigmentation and eye regression (Deeleman-Reinhold 1983). More specifically, the size of the anterior median eyes (AME) appears to be conspicuously reduced in the subterranean species, compared to their surface-dwelling relatives; for instance, a conspicuous reduction of the AME is found in *H. bidens* (Absolon & Kratochvíl, 1933), *H. dubia* (Absolon & Kratochvíl, 1933), *H. palaeolithica* (Brignoli, 1971), and *H. thaleri* Gasparo, 2005 (Absolon & Kratochvíl 1933; Kratochvíl 1938: p. 16, figs. 20, 24; Brignoli 1971; Gasparo 2005).

Within the genus, the species with the highest level of troglomorphism is possibly *H. palaeolithica* (Brignoli, 1971). *H. palaeolithica* was described on the basis of one female and one juvenile collected in 1967 by Augusto Vigna-Taglianti in the Arma delle Arene Candide cave (Liguria, Italy). According to the original description (Brignoli 1971: p. 128), this species has only six eyes, because AME are replaced by two small spots of black pigment (Figure 1a). The species had never been collected after the original description (Pantini & Isaia 2019; Mammola et al. 2018), and the male is as yet undescribed. With the aim of filling this taxonomical gap, between 2015 and 2018 we conducted repeated biospeleological prospections in the *locus typicus* and in several caves in the nearby area.

While our extensive surveys in the *locus typicus* failed in recovering the presence of the species, we found a new population in a cave opening a few hundred meters away from the type locality.

As a result of this finding, we provide the first description of the male of *H. palaeolithica*, as well as a re-description of the female based on specimens collected in the new locality. In parallel, we provide the description of a new species of *Histopona*, based on the record of a female specimens from the Golubova pećina cave in Montenegro, which was formerly attributed to *H. palaeolithica* by Naumova et al. (2016). In light of the rarity of these species, we provide general information on their ecology and conservation status, including details allowing the assessment of the extinction risk according to the IUCN Red List Categories and Criteria (IUCN 2001, 2012).

METHODS

We stored most specimens in 75% ethanol at Marco Isaia's collection at Department of Life Sciences and Systems Biology, University of Torino (Italy). We preserved a few specimens in absolute ethanol for future DNA analysis. We further deposited a few specimens at Museo Civico di Scienze Naturali "E. Caffi" (Bergamo, Italy)—labelled with the acronym "MCSN". We deposited the holotype of the new species here described at the National Museum of Natural History Bulgarian Academy of Sciences (Sofia, Bulgaria)—acronym "NMNHS". We studied specimens using a Leica M80 stereoscopic binocular. We acquired all measurements in millimetres (mm), using a Leica M80 stereoscopic microscope (up to 60x magnification). Measurements were taken from digital pictures made with a Leica EC3 digital camera, and calculated with the Leica LAS EZ 3.0 software (Leica Microsystems, Switzerland). All measurements are given in mm. We referred to

WSC (2019) for current nomenclature. We gave the speleological cadastral codes of the caves in squared brackets ['regional code' and 'number']. Coordinates of localities are given in WGS84, decimal degrees.

Abbreviations.—AER = anterior eye row; ALE = anterior lateral eyes; ALS = anterior lateral spinnerets; AME = anterior median eyes; AOO = Area of Occupancy; d = dorsal; EOO = Extent of Occurrence; Fe = femur; MCSNB= Museo Civico di Scienze Naturali "E. Caffi" di Bergamo; Me = metatarsus; MSNV = Museo di Storia Naturale di Verona; NMNHS = National Museum of Natural History Bulgarian Academy of Sciences, Sofia; p = prolateral; Pa = Patella; PER = posterior eye row; PLE= posterior lateral eyes; PLS = posterior lateral spinnerets; PME = posterior median eyes; PMS = posterior median spinnerets; r = retrolateral; RTA = retrolateral tibial apophysis; Ta = tarsus; Ti = tibia; v = ventral. Abbreviations used in figures are listed in the relative captions.

RESULTS

Family **AGELENIDAE** C. L. Koch, 1837

Genus ***Histopona*** Thorell, 1869

Histopona palaeolithica **(Brignoli, 1971)**

Material examined.—Arma delle Arene Candide [Li 34] (44.16233° N, 8.32831° E), promontory Caprazoppa, Finale Ligure, Liguria (SV), Italy, 25.xi.1967: Vigna-Taglianti A. leg. 1 ♀ (holotype), 1juv. (MSNV). Pozzo delle Cento Corde [Li 137] (44.16306 N, 8.31822 E), promontory Caprazoppa, Campi di Orso, Borgio Verezzi, Liguria (SV), Italy, 23.xii.2016: Alterisio D., Isaia M. & Mammola S. leg. 4♀♀; same locality; 06.iii.2017: Isaia M. & Mammola S. leg. 1♀ 1♂juv. (MCSNB); 20.iv.2017: Isaia M. leg. 2♀♀ 2juv.; same locality, 18.x.2017: Isaia M. & Mammola S. leg. 2♀♀ 3 juv.; same locality, 02.vi.2018: Biggi E., Isaia M. & Mammola S. 2♀♀ 1♂.

Diagnosis.—Males of *Histopona palaeolithica* are best diagnosed by the shape of the tegulum and the positions of the origin and the distal tip of the embolus. Compared to the species of *Histopona* assigned to the *myops, strinatii* and *torpida* groups, the embolus is shorter, but it is longer in respect to the *italica* group. Additional diagnostic characters are the shape of the conductor and the cymbium, the latter being less elongated in respect to the *myops* group and more elongated than in *torpida* and *italica* groups.

Description of the male.—Measurements (n=1): Total length 4.98 (including spinnerets). Cephalothorax 1.77 long, 1.32 wide. Prosoma yellow-brown. Sternum yellow-brown, without pattern. Head region of the same colour, 0.70 wide. PER 0.37 wide, AER 0.25. Eye diameter: AME 0.01 (no corneal lens is visible), ALE: 0.06; PME: 0.04; PLE: 0.06. Both eye rows recurved in dorsal view. AME reduced to a small spot of pigment, other eyes normally developed (Figure 1a). Clypeus height under AME: 0.07, under ALE: 0.09. Chelicerae: 0.62 long, 0.31 wide. Labium as long as wide or moderately wider than long. Sternum 1.08 long, 0.84 wide. Gnathocoxa ratio (width to length): 0.57. Chelicerae: with 3

teeth on promargin and 5 teeth on retromargin. Opisthosoma 2.48 long (including spinnerets), grey-white without pattern. Colulus reduced, only two hairy plates are visible. Legs: I 6.83 (Fe 1.81) (Pa 0.52) (Ti 1.68) (Me 1.66) (Ta 1.16); II 6.03 (Fe 1.60) (Pa 0.42) (Ti 1.44) (Me 1.45) (Ta 1.12); III 5.82 (Fe 1.54) (Pa 0.39) (Ti 1.34) (Me 1.47) (Ta 1.08); IV 7.57 (Fe 1.88) (Pa 0.55) (Ti 1.84) (Me 2.13) (Ta 1.17); same colour as prosoma, all trochanters notched. Chaetotaxy: I (Fe 2d, 1p, 1r) (Pa 2d) (Ti 2d, 2p, 1r, 2v) (Me 2p, 2r, 4v); II (Fe 2d, 2p, 1r) (Pa 2d) (Ti 2d, 2p, 1r, 4v) (Me 2p, 5v); III (Fe 2d, 2p, 1r) (Pa 2d) (Ti 2d, 2p, 2r, 3v) (Me 5d, 2p, 2r, 5v); IV (Fe 2d, 2p, 1r) (Pa 2d) (Ti 2d, 2p, 2r, 5v) (Me 2d, 3p, 2r, 3v) (Ta 1r). PLS longer than all others, distal segment as long as basal segment. PMS as long as ALS. Palp (Figure 1b–d): 2.02 (Fe 0.65) (Pa 0.21) (Ti 0.19) (Ta 0.87); RTA with a sclerotized dorsal branch, distally pointed; lateral branch forming a finger-shaped appendix; ventral branch forming a stout appendix, protruding ventrodistally. Cymbium elongated, similar to the species included in the *strinatii* group, less elongated than in the *myops* group, more elongated than in *torpida* and *italica* groups. Ratio bulb length (laterally from cymbium base to conductor tip) to cymbium length: 0.68. Tegulum ring-shaped, ending in a filiform embolus originating at 7 o'clock position, with distal tip between 4 and 5 o'clock position. Embolus shorter than in *myops, strinatii* and *torpida* groups, longer than in the *italica* group. Conductor lamella-like, distally broadly rounded. Connection of conductor and tegulum membranous, band-like. Median apophysis and tegular apophysis absent.

Description of the female.—Measurements (n=1; specimen from Pozzo delle Cento Corde collected on 20.iv.2017). Total length: 4.86 (including spinnerets). Cephalothorax 2.07 long, 1.35 wide. Prosoma yellow-brown. Sternum yellow-brown, without pattern. Head region of the same colour, 0.83 wide. PER: 0.32 wide, AER: 0.25. Eye diameter: AME: 0.02 (no corneal lens is visible), ALE: 0.06; PME: 0.03; PLE: 0.07. Both eye rows recurved

in dorsal view. AME reduced to a small spot of pigment, other eyes normally developed. Clypeus height under AME: 0.08, under ALE: 0.10. Chelicerae 0.79 long, 0.41 wide. Labium as long as wide or moderately wider than long. Gnathocoxa ratio (width to length): 0.60. Chelicerae: with 3 teeth on promargin and 5 teeth on retromargin. Sternum 1.14 long, 0.97 wide. Opisthosoma 2.78 long (including spinnerets), grey-white without pattern. Colulus reduced, only two hairy plates are visible. Legs: I 7.21 (Fe 2.00) (Pa 0.66) (Ti 1.71) (Me 1.64) (Ta 1.20); II 6.61 (Fe 1.77) (Pa 0.70) (Ti 1.51) (Me 1.55) (Ta 1.08); III 6.36 (Fe 1.81) (Pa 0.62) (Ti 1.35) (Me 1.57) (Ta 1.01); IV 7.15 (Fe 2.13) (Pa 0.64) (Ti 1.39) (Me 2.12) (Ta 0.87); same colour as prosoma, all trochanters notched. Chaetotaxy: I (Fe 2d, 1p, 1r) (Pa 2d) (Ti 2p, 4v) (Me 2p, 3r, 3v); II (Fe 2d, 2p, 1r) (Pa 2d) (Ti 2p, 4v) (Me 2p, 2v); III (Fe 2d, 2p, 1r) (Pa 2d) (Ti 1d, 2p, 2r, 5v) (Me 2d, 3p, 3r, 1v); IV (Fe 2d, 2p, 1r) (Pa 2d) (Ti 1d, 2p, 3r, 4v) (Me 1d, 2p, 2r, 4v) (Ta 1r). PLS longer than all others with distal segment as long as basal segment. PMS as long as ALS. Palp: 2.31 (Fe 0.72) (Pa 0.27) (Ti 0.48) (Ta 0.84); chaetotaxy: (Fe 3d) (Pa 2d) (Ti 2d, 4p, 5r). Epigynum and vulva (Figure 2a–c): Epigynal plate 0.24 long, 0.30 wide, poorly sclerotized, subtriangular, marsupium-like, with a small undivided epigynal valve arising from the posterior margin (*sensu* Deeleman-Reinhold 1983) covering the copulatory openings. Copulatory duct paired leading to the paired genital pouch, anteriorly straight or convex, directing into poorly sclerotized and pigmented rounded receptacula; fertilization ducts very short (Figure 2c).

Distribution, sampling notes and ecology.—*Histopona palaeolithica* is restricted to subterranean habitats in the promontory of Caprazoppa (291 m a.s.l.), located at ca. 0.5 km from the Mediterranean (Ligurian) shore. One population is reported in literature (Brignoli 1971) from the locus typicus, the Arma delle Arene Candide [Li 34] cave. A second population is herein documented for the Pozzo delle Cento Corde [Li 137] cave.

Both caves open in stretches of Mediterranean scrubland.

Between 2015 and 2016, we conducted six visits to Arma delle Arene Candide, a 667 m long cave with restricted access due to the presence of remarkable paleontological remains (Mussi 2005; Catasto Spelologico Ligure 2018). In spite of our sampling efforts, including pitfall trapping inside the cave and in its surroundings, we were unable to find specimens of *H. palaeolithica*. In recent years, part of the cave was destroyed by the extension works of a large quarry. We believe that a secondary entrance, which was opened as a consequence of the mining activities, caused the alteration of air circulation patterns, determining changes in local microclimatic conditions including the drying of the cave, which now results in an abundant presence of dust. According to the original collector, at the time of the collection of the type material (1967), the climatic conditions of the cave were remarkably different from the current ones, with high humidity and mud on the floor rather than dust (Vigna-Taglianti A, pers. Comm. 2016). We hypothesize that these environmental alterations are likely to be the main cause of the extinction of the local population of *H. palaeolithica* in the cave. It is worth noting that the cave is *locus typicus* of four additional arthropods (Conci 1952), including the arachnids *Leptoneta crypticola franciscoloi* di Caporiacco, 1950 (Araneae: Leptonetidae) and *Chthonius* (*Ephippiochthonius*) *concii* Beier, 1953 (Pseudoscorpiones: Chthoniidae), which were similarly never found during our surveys.

Conversely, individuals of *H. palaeolithica* are locally abundant in the Pozzo delle Cento Corde [Li 137] cave. This is a small vertical cave, whose entrance (1x1.5 m) opens at the base of the limestone cliff of the “Falesia delle Cento Corde” climbing site. The cave has a drop of –24 m and a total planimetric development of 36 m (Catasto Spelologico Ligure, 2018). Individuals of *H. palaeolithica* were primarily found at the base of the first pit (–10 m), especially among the humid debris on the floor of the first room (10x10x4 m).

Pozzo delle Cento Corde is a dry cave with a ground temperature ranging from approximately 21 °C in the entrance area to 17 °C in the innermost sections —climatic data based on winter temperature measurements by Motta & Motta (2017). In the first room, where most individuals were collected, ground temperature ranges from 19.2 to 20.9 °C and relative humidity from 60 to 70 % (Motta & Motta 2017).

Aside from caves, *H. paleolithica* probably lives in interstitial habitats, such as narrow fissures in limestone rocks or under deep stones. The species spins a 5–7 cm wide sheet web, lacking a funnel (Figure 3). The spider stands on top of the web (Figure 3a–c). Females are abundant throughout the year, while males appear to be rare—five visits between 2016 and 2018 were necessary to found a single male specimen.

Conservation status and basic information for the species IUCN Red List assessment.—Range description, Area of Occupancy (AOO) and Extent of Occurrence (EOO): the species is endemic to the Caprazoppa promontory (min–max elevation: 0–291 m). In spite of our exhaustive searches in caves on the Western Ligurian shore (Riviera di Ponente), and more specifically in the areas of Borgio Verezzi and Finale Ligure, including the type locality (Arma delle Arene Candide), we only found a population in the Pozzo delle Cento Corde cave. The estimated EOO and AOO are both extremely small, less than 1 km^2. We infer a decline in both EOO and AOO as a result of quarrying activities. Dispersal ability for this species is not known, but since this is a highly specialized cave-dwelling species with restricted range, it is assumed that it has a very low dispersal capacity.

Locations: the only location known for this species is the Pozzo delle Cento Corde cave. As a result of changes in local microclimatic conditions due to quarrying activity, we consider the population of the type locality, Arma delle Arene Candide cave, locally extinct.

The whole area of the Caprazoppa promontory is currently subject to quarrying activities, which are likely to represent a major threat to the species' survival.

Threats: the species is potentially exposed due to its extremely narrow geographic distribution range and its low dispersal capacity. Given the general low tolerance to habitat changes of subterranean organisms, it is suspected that quarrying activities in the area may interfere with the species' survival. Secondary impacts could derive from tourism, due to the high number of climbers and hikers in the area. Moreover, the cave opening is easily accessible and located at the base of the climbing site. If, on one hand, climbing activities do not represent a direct threat for species survival, the possible accumulation of litter thrown by tourists in the cave could cause changes in the cave environment and decrease habitat quality.

Conservation actions: in light of the mentioned threats, it is worth considering the extinction risk of *H. palaeolithica*. As very little is known about the biology and life history of this species, to date it is not possible to provide any precise management actions. However, the inclusion of this species in the IUCN Red List represents an important starting point for its conservation. As seen for other subterranean systems of conservation concern for red listed and legally protected species, *H. palaeolithica* could benefit from effective protection with adequate legislation aiming to preserve the Caprazoppa promontory from future expansion of quarrying activities. In addition, a strict code of conduct and specific guidelines for touristic, speleological and other activities inside and outside the Pozzo delle Cento Corde cave should be implemented. The installation of informative posters and correct actions of popularization of the cave biological peculiarity (i.e. in tourist guides) should be promoted.

***Histopona petrovi* Isaia & Mammola sp. nov.**

Material examined.—Golubova Pećina cave (42.21° N, 19.13° E), Seoca village, Virpazar district, Montenegro, 12.viii.2006, Petrov B., Lazarov S. leg. 1♀ [Sub *Histopona palaeolithica* in Naumova et al. (2016)] (Holotype, deposited at NMNHS).

Diagnosis.—*Histopona petrovi* sp. nov. is best diagnosed by the vulva viewed dorsally, in particular by the shape of the spermathecae, conspicuous, tubular and arc-shaped. In comparison with *H. palaeolithica,* they are much more sclerotized and pigmented. The undivided valve of the epigyne arising from the posterior margin is also diagnostic, being trapezoidal rather than subtriangular, slightly curved in the middle and more pronounced than in *H. palaeolithica* (almost protruding when seen from above or from the side).

Description.—Measurements (n=1, holotype female). Total length: 4.58 (including spinnerets). Cephalothorax 1.95 long, 1.37 wide. Prosoma yellow-brown. Sternum yellow-brown, without pattern. Head region of the same colour, 0.84 wide. PER 0.35 wide, AER 0.22 wide. Eye diameter: AME: 0.01 (no corneal lens is visible), ALE: 0.04; PME: 0.03; PLE: 0.06. Both eye rows recurved in dorsal view. AME reduced to a very small spot of pigment, other eyes normally developed (Figure 4a). Clypeus height under AME: 0.11, under ALE: 0.13. Chelicerae 0.89 long, 0.38 wide. Labium as long as wide or moderately wider than long. Sternum 1.03 long, 0.96 wide. Gnathocoxa ratio (width to length): 0.42. Chelicerae: with 3 teeth on promargin and 5 teeth on retromargin. Opisthosoma 2.43 long (including spinnerets), grey-white without pattern. Colulus reduced, only two hairy plates are visible. Legs: I 7.70 (Fe 2.01) (Pa 0.66) (Ti 1.84) (Me 1.85) (Ta 1.34); II 7.05 (Fe 1.86)

(Pa 0.60) (Ti 1.68) (Me 1.76) (Ta 1.15); III 6.82 (Fe 1.73) (Pa 0.58) (Ti 1.60) (Me 1.72) (Ta 1.19); IV 9.06 (Fe 2.32) (Pa 0.51) (Ti 2.31) (Me 2.50) (Ta 1.42); same colour as prosoma, all trochanters notched. Chaetotaxy: I (Fe 2d, 2p, 1r) (Pa 2d) (Ti 2d, 2p, 1r, 2v) (Me 2p, 2r, 4v); II (Fe 2d, 2p, 1r) (Pa 2d) (Ti 2d, 2p, 2r, 3v) (Me 4p, 3v, 3r); III (Fe 2d, 1r) (Pa 2d) (Ti 2d, 2p, 3r, 3v) (Me 3d, 4p, 2r, 4v); IV (Fe 2d, 2p, 1r) (Pa 2d) (Ti 2d, 2p, 3r, 5v) (Me 2d, 3p, 3r, 6v) (Ta 1r). PLS longer than all others, with distal segment as long as basal segment. PMS as long as ALS. Palp: 4.92 (Fe 0.62) (Pa 0.30) (Ti 0.60) (Me 0.94) (Ta 2.46); chaetotaxy: (Fe 3d) (Pa 2d) (Ti 2d, 5r, 4p). Epigynum (Figure 4b–c) and vulva (Figure 4d): epigynal plate 0.30 long, 0.39 wide, poorly sclerotized, trapezoidal, marsupium-like, with an undivided epigynal valve (*sensu* Deeleman-Reinhold 1983) arising from the posterior margin and covering the copulatory openings, recalling in shape the small undivided valve of *H. palaeolithica*, but bigger and slightly curved in the central part. When seen from above or from the side, the valve is protruding (more than in *H. palaeolithica*). Copulatory paired ducts leading to the paired genital pouch, directing into the heavily sclerotized and pigmented arc-shaped receptacula, not visible in dorsal view, but clearly visible after epigyne extraction, in dorsal view; fertilization ducts short but visible (Figure 4d).

Etymology.—The species is dedicated to the Bulgarian zoologist and alpinist Boyan Petrov (1973–2018), one of the collectors of the type material. Boyan disappeared climbing his tenth eight-thousand peak in Himalaya, the Shishapangma (8,027 m).

Distribution, sampling notes and ecology.—The species is exclusively known by a single specimen collected in the Golubova pećina cave. This is a narrow cave of about 100–150 m, opening at an altitude of 440 m in rocky habitats. The specimen was collected in the dark zone, about 40 m deep, under a stone. Cave internal temperature is around 14

°C (Stoev & Enghoff 2008). Based on the morphological troglomorphism, in particular the depigmentation and AME reduction, we regard *Histopona petrovi* sp. nov. as a subterranean adapted species, likely troglobiont (as defined in Mammola & Isaia 2017). Further information on the natural history and ecological preference are required to confirm this observation.

Conservation status and basic information for the species IUCN Red List assessment.—*Histopona petrovi* sp. nov. is only known by a female specimen collected in the Golubova pećina cave. There is currently no information on the species distribution, ecology and natural history, hindering the possibility of a direct or an indirect assessment of its risk of extinction—the Red List category Data Deficient (DD) should be therefore used in the event of a formal IUCN assessment. Basic research is needed to estimate the conservation status and the possible threats affecting this species.

CONCLUDING REMARKS

Histopona palaeolithica and *H. petrovi* sp. nov. exhibit somatic characters that justify their genus placement in *Histopona* (see Deeleman-Reinhold 1983; Bolzern et al. 2013). These include eye arrangement, elongated sternum—i.e. reaching backwards between coxae IV,—notched trochanters, leg spination (two dorsal spines on Fe II and two or more prolateral spines on Mt I), reduced colulus and absence of abdominal or leg pattern. This interpretation also fits the case of the newly discovered male of *H. palaeolithica*, showing typical characters also in the male genitalia, namely more than one palpal tibial apophysis, an elongated cymbium and a long and thread-like embolus.

Based on morphological characters referring to female and partly to male genitalia, Deeleman-Reinhold (1983) classified the extant species of *Histopona* into five species

groups. Authors describing new *Histopona* species after 1983, kept on using this classification by adding species to the extant groups or, in one case (*H. breviemboli*), suggesting that the species could not be placed in any of the extant groups (Dimitrov et al. 2017). Excluding the latter self-standing species, the extant groups are: *torpida* (7 species, from Central Europe to Caucasus)*, myops* (7 species, Balkans)*, strinatii* (2 species, Greece)*, italica* (3 species, Italy) and *palaeolithica* (2 species, including *H. palaeolithica* from Italy and the newly described *H. petrovi* sp. nov. from Montenegro) (Figure 5). Due to the absence of the male, Deeleman-Reinhold (1983) placed *H. palaeolithica* in a separate and self-standing group based on female characters, namely the peculiar small and undivided epigynal valve, a character shared with the monotypic genus *Hadites* and with some species of *Malthonica*.

When considering our new findings, the male of *H. paleaolithica* exhibits some affinity with the species included in *myops* and *strinatii* groups (male palp with conductor, but no apophysis on the radix). *H. petrovi* sp. nov. could also be placed in the *palaeolithica* group in relation to the presence of a relatively small and undivided epigynal valve. From a morphological point of view, both species in the *palaeolithica* group seem, to a certain extent, also related to *Hadites tegenarioides* Keyserling, 1862, described on the basis of one female and juvenile males from the island of Hvar (Croatia), approximately 180 km north from Golubova Pećina, along the Adriatic shore (Figure 5), whose taxonomical status appears in need of revision. However, in the absence of a proper morphological or molecular phylogenetic quantitative evaluation, the delimitations of the species groups and the phylgenetic position of *H. palaeolithica* and *H. petrovi* sp. nov., as well as their relation with the genus *Hadites*, remain speculative.

The morphological peculiarity of *H. palaeolithica* is mirrored by its geographic distribution at the western periphery of the genus range and by the lack of closely related

species in the same area (Figure 5). Except for *H. torpida* and *H. luxurians*, showing wider distribution in Europe and Eastern Europe, respectively, the genus *Histopona* is represented by mid or small-ranged species, most of them distributed in SE Europe. Congeneric species occurring in Italy are represented by species included in the *italica* group (*H. leonardoi, H. fioni* and *H. italica*, Alps and Apennines; see Bolzern et al. 2013), and *H. torpida* (*torpida* group), with recent records in NE Italy (Isaia et al. 2007; Ballarin et al. 2011; Hansen 2011; Trotta & Cherubini 2017) and old, poorly reliable records on the Italian and the French slope of the Maritime Alps (Thorell 1875; Calloni 1889; Berktau 1890).

ACKNOWLEDGEMENTS

Special thanks are due to Christo Deltshev and Maria Naumova for providing the type material of *Histopona petrovi* sp. nov. We are thankful to Emanuele Biggi for providing photos of *H. palaelothica* in its habitat, and to Angelo Bolzern for useful comments on taxonomy. We thank Elisio Bonora for providing access to the Arma delle Arene Candide cave. Deborah Alterisio, Giovanni Badino, Emanuele Biggi, Andrea John Dejanaz and Raffaella Zerbetto assisted us in the field. A special thanks goes to Paolo Pantini for his assistance and to Elena Pelizzoli for drawing the illustrations provided in the paper.

This paper is dedicated to the memory of Prof. Augusto Vigna Taglianti (1943-2019), estimated Italian zoologist and good friend of many of us. We are grateful for the major contribution he gave to the knowledge of the Italian fauna and for being a constant source of inspiration for the whole Italian scientific community, especially for the young zoologists. The finding of *H. palaeolithica* was indeed stimulated by the information he shared with us about the collection site of the type series of this species.

LITERATURE CITED

Absolon, K. & J. Kratochvíl. 1933. Über höhlenbewohnende Arachniden. Vorläufige Mitteilung. Acta Musei Moraviae 29:595–600.

Ballarin, F., P. Pantini P. & H. Hansen H. 2011. Catalogo ragionato dei ragni (Arachnida, Araneae) del Veneto. Museo Civico di Storia Naturale di Verona, Serie 2, Sezione Scienze della Vita.

Bertkau, P. 1890. Arachniden gesammelt vom 12 November 1888 bis zum 10 Mai 1889 in San Remo von Prof. Dr Oskar Schneider: 1–11.

Bolzern, A., P. Pantini & M. Isaia. 2013. Revision of the *Histopona italica* group (Araneae: Agelenidae), with the description of two new species. Zootaxa 3640:23–40.

Brignoli, P.M. 1971. Contributo alla conoscenza degli Agelenidae italiani (Araneae). Fragmenta Entomologica 8:57–142.

Brignoli, P.M. 1972. Su alcuni ragni cavernicoli di Corfù (Arachnida, Araneae). Revue Suisse de Zoologie 79:861–869.

Brignoli, P.M. 1977a. Ragni di Grecia X. Nuovi dati sulla Grecia continentale ed insulare (Araneae). Revue Suisse de Zoologie 84:937–954.

Brignoli, P.M. 1977b. Ragni d'Italia XXVII. Nuovi dati su Agelenidae, Argyronetidae, Hahniidae, Oxyopidae e Pisauridae cavernicoli ed epigei (Araneae). Quaderni del Museo di Speleologia "V. Rivera" 4:3–117.

Calloni, E. 1889. La fauna nivale con particolare riguardo al viventi delle alte Alpi. Pavia.

Catasto Speleologico Ligure 2018. Online at http://www.catastogrotte.net/Navigator-view-137.html

Christiansen, K.A. 2012. Morphological adaptations. Pp. 517–528. *In* Encyclopedia of caves (W.B. White & D.C. Culver, ed.). Elsevier, Amsterdam.

Conci, C. 1952. Le Arene Candide n. 34 Li. Doriana 1:1–12.

Deeleman-Reinhold, C.L. 1983. The genus *Histopona* Thorell (Araneae, Agelenidae) with description of two new cave-dwelling species. Mémoires de Biospéologie 10:325–337.

Deltshev, C. 1978. A new *Histopona* (Araneae, Agelenidae) from Bulgarian caves. Acta Zoologica Bulgarica 10:57–59

Deltshev, C. & B. Petrov. 2008. The spiders (Araneae) in the caves of the western Rhodope Mountains (Bulgaria). Acta Zoologica Bulgarica 60:41–50.

Dimitrov, D., C. Deltshev & S. Lazarov. 2017. Description of *Histopona breviemboli* sp. n. from the Balkan Peninsula (Arachnida, Araneae, Agelenidae). *Zootaxa* 4311:283–286.

Gasparo, F. 2005. Note sulle *Histopona* Thorell, 1869, del gruppo *Myops* di Grecia, con descrizione di una nuova specie cavernicola (Araneae, Agelenidae). Atti e Memorie, Commissione Grotte "Eugenio Boegan" 40:17–35.

Hansen, H. 2011. Contributo alla conoscenza dell'araneofauna di alcuni biotopi naturali del

Friuli Venezia Giulia (Arachnida Araneae). Gortania Botanica Zoologica 32:115–134.

Isaia, M., P. Pantini, S. Beikes & G. Badino. 2007. Catalogo ragionato dei ragni (Arachnida, Araneae) del Piemonte e della Lombardia. Memorie dell'Associazione Naturalistica Piemontese 9:9–161

IUCN. 2001. IUCN Red List Categories and Criteria: Version 3.1. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge.

IUCN. 2012. IUCN Red List Categories and Criteria. Version 3.1, 2nd Edition, IUCN Species Survival Commission. IUCN, Gland.

Kratochvíl, J. 1938. Étude sur les araignées cavernicoles du genre *Hadites.* Práce Morava Prírod Spol 11:1–28.

Mammola, S. & M. Isaia. 2017 Spiders in caves. Proceedings of the Royal Society B: Biological Scinces 284: 20170193.

Mammola, S., P. Cardoso, C. Ribera, M. Pavlek & M. Isaia. 2018. A synthesis on cave-dwelling spiders in Europe. Journal of Zoological Systematics and Evolutionary Research 56:301–316.

Motta, M. & L. Motta. 2017. The Cento Corde cave (Rocce dell'Orera karstic plateau, Ligury, NW Italy): a fossil ponor developed toward down, without water circulation. Pp. 37–40. *In The climatic study of caves with single entrance: temperatures, humidity, thermal exchange* (M. Motta& L. Motta ed.). Lulu, Raleigh.

Mussi, M. 2005. Arene Candide, arte paleolitica (Finale Ligure). Archeologia in Liguria Nuova Serie, De Ferrari, Genova.

Naumova, M.V., S. Lazarov, B. Petrov, & C. Deltshev. 2016. New faunistic data on the cave-dwelling spiders in the Balkan Peninsula (Araneae). Ecologia Montenegrina 7:425–438.

Pantini P., Isaia M. (in press). Araneae.it: the online Catalog of Italian spiders with addenda on other Arachnid Orders occurring in Italy (Arachnida: Araneae, Opiliones, Palpigradi, Pseudoscorpionida, Solifugae). Fragmenta Entomologica *in press*.

Stoev, P. & H. Enghoff. 2008. A revision of the millipede tribe Apfelbeckiini Verhoeff, 1900 (Diplopoda: Callipodida: Schizopetalidae). Steenstrupia 30:47–66.

Thorell, T. 1875. Descriptions of several European and North African spiders. Kongliga Svenska Vetenskaps-Akademiens Handlingar 13:1–203.

Trotta, A. & A. Cherubini. 2017. Contributo alla conoscenza dei ragni (Arachnida, Araneae) del Veneto. Bollettino del Museo Civico di Storia Naturale di Verona 41:55–86.

World Spider Catalog—WSC. 2019. World Spider Catalog. Version 20.0. Natural History Museum Bern. Online at http://wsc.nmbe.ch/

FIGURE CAPTIONS

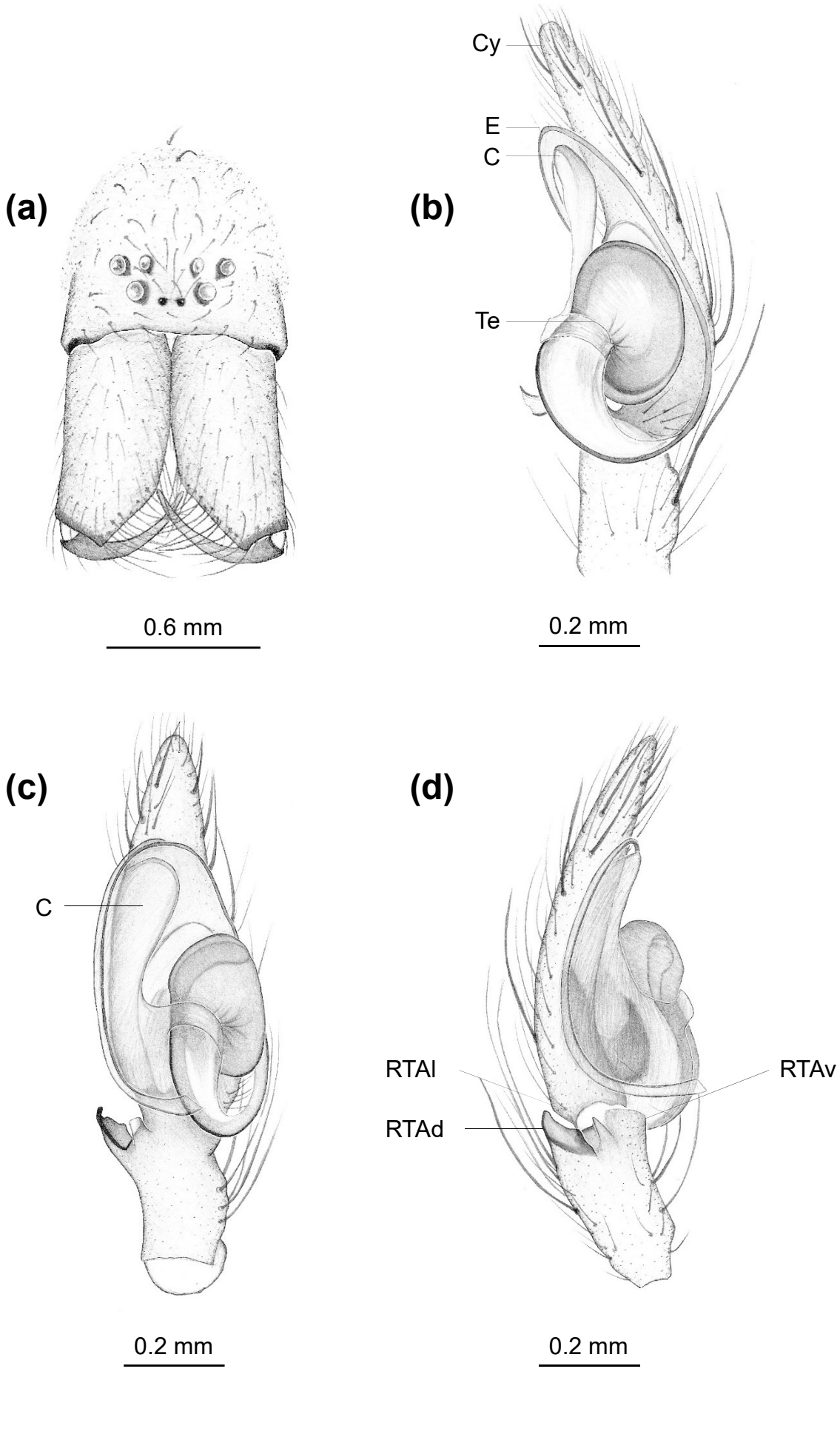
Figure 1. *Histopona palaeolithica* (Brignoli, 1971) (Araneae: Agelenidae), male from Pozzo delle Cento Corde [Li 137], 2.vi.2018, leg. Isaia, Biggi & Mammola. a. Head region, frontal view; b. Right palp, ventral view; c. d Right palp, retrolateral view (orientation 45°); d. Right palp, retrolateral view (orientation 90°). Abbreviations: C= Conductor; Cy= Cymbium; E= Embolus; RTAd= dorsal branch of RTA; RTAl= lateral branch of RTA; RTAv = ventral branch of RTA, Te= Tegulum. Illustrations: Elena Pelizzoli.

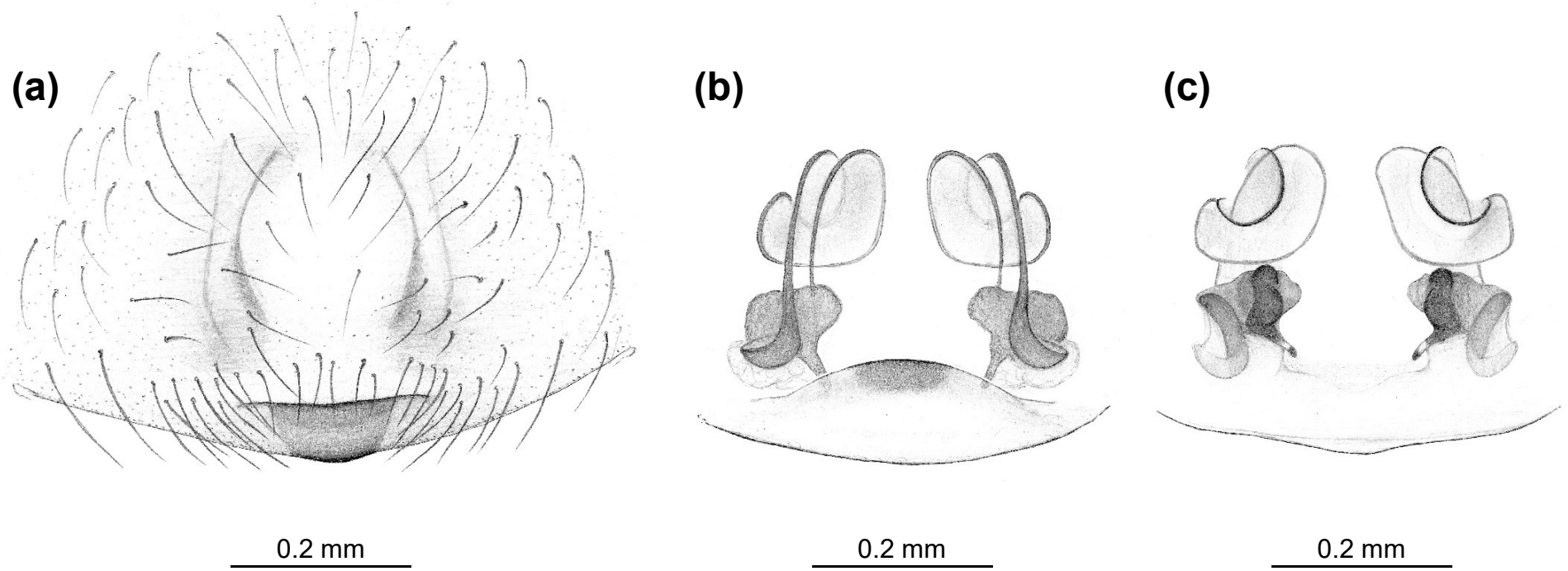
Figure 2. *Histopona palaeolithica* (Brignoli, 1971) (Araneae: Agelenidae), female from Pozzo delle Cento Corde [Li 137], 20.iv.2017, leg. Isaia. a. Epigyne, ventral view; b. Epigyne cleared, ventral view; c. Vulva. Abbreviations: Cd= Copulatory duct; Ev= Epigynal valve; Fd= Fertilization duct; Gp= Genital pouch; R= Receptaculum. Illustrations: Elena Pelizzoli.

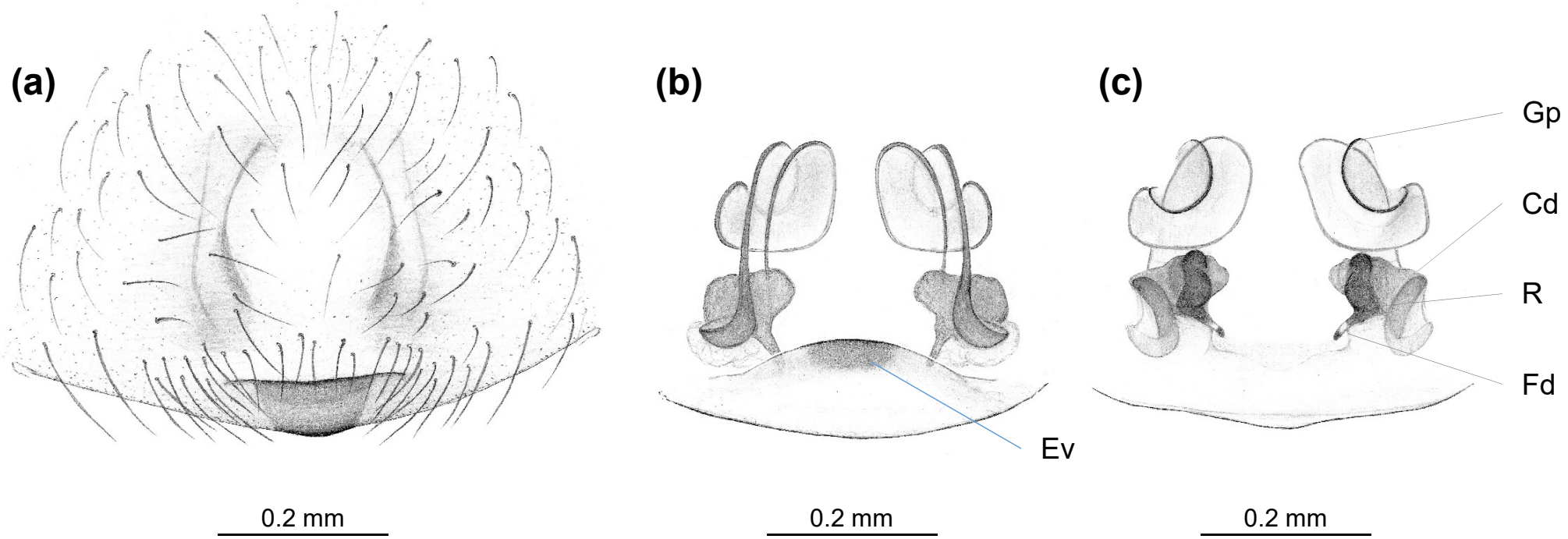
Figure 3. *Histopona palaeolithica* (Brignoli, 1971) (Araneae: Agelenidae), male from Pozzo delle Cento Corde [Li 137], 2.vi.2018, leg. Isaia, Biggi & Mammola. a–c. Habitus of the male; d. Shape of the web. Photo credits: Emanuele Biggi.

Figure 4. *Histopona petrovi* Isaia & Mammola sp. nov. (Araneae: Agelenidae), holotype female from Golubova pećina, 12.viii.2006, leg. Petrov & Lazarov. a. Head region in frontal view; b. Epigyne, ventral view; c. Epigyne cleared, ventral view; d. Vulva. Abbreviations: Cd= Copulatory duct; Ev= Epigynal valve; Fd= Fertilization duct; Gp= Genital pouch; R= Receptaculum. Illustrations: Stefano Mammola and Elena Pelizzoli.

Figure 5. Distribution range of the genus *Histopona* and the related species *Hadites tegenarioides* Keyserling, 1862*,* with reference to the species groups proposed by Deeleman-Reinhold (1983).


(a)
0.6 mm
(b)
Cy
E
C
Te
0.2 mm
(c)
C
0.2 mm
(d)
RTAl
RTAv
RTAd
0.2 mm


(a)
(b)
(c)
0.2 mm
0.2 mm
0.2 mm


(a)
(b)
(c)
Gp
Cd
R
Fd
Ev
0.2 mm
0.2 mm
0.2 mm

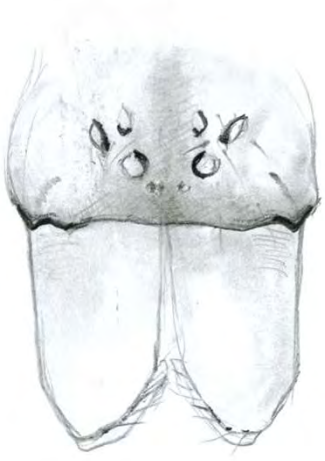

a


b


c

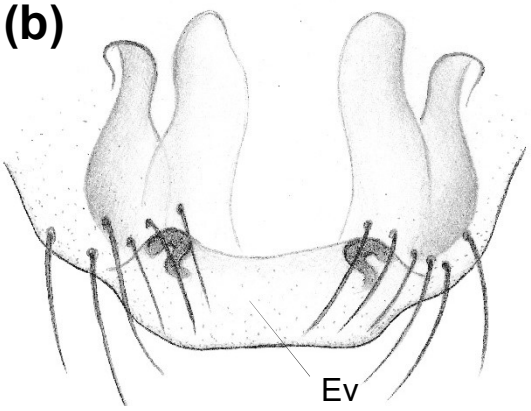

d

(a)



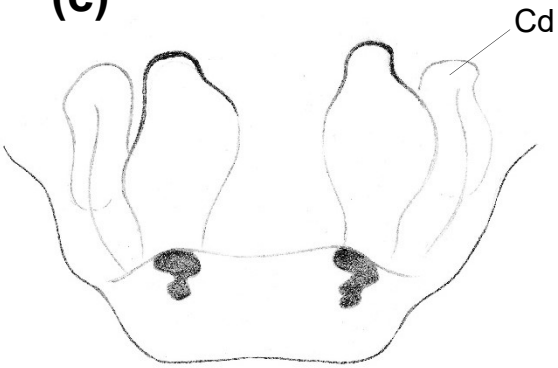
0.8 mm

(b)



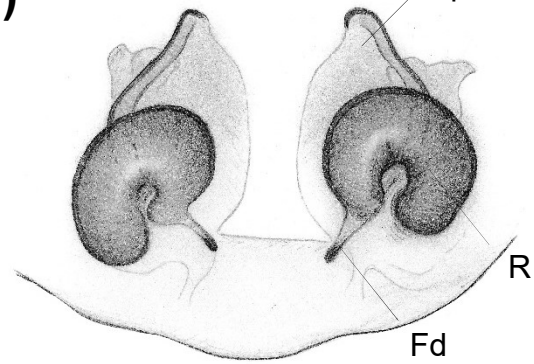
0.2 mm

(c)

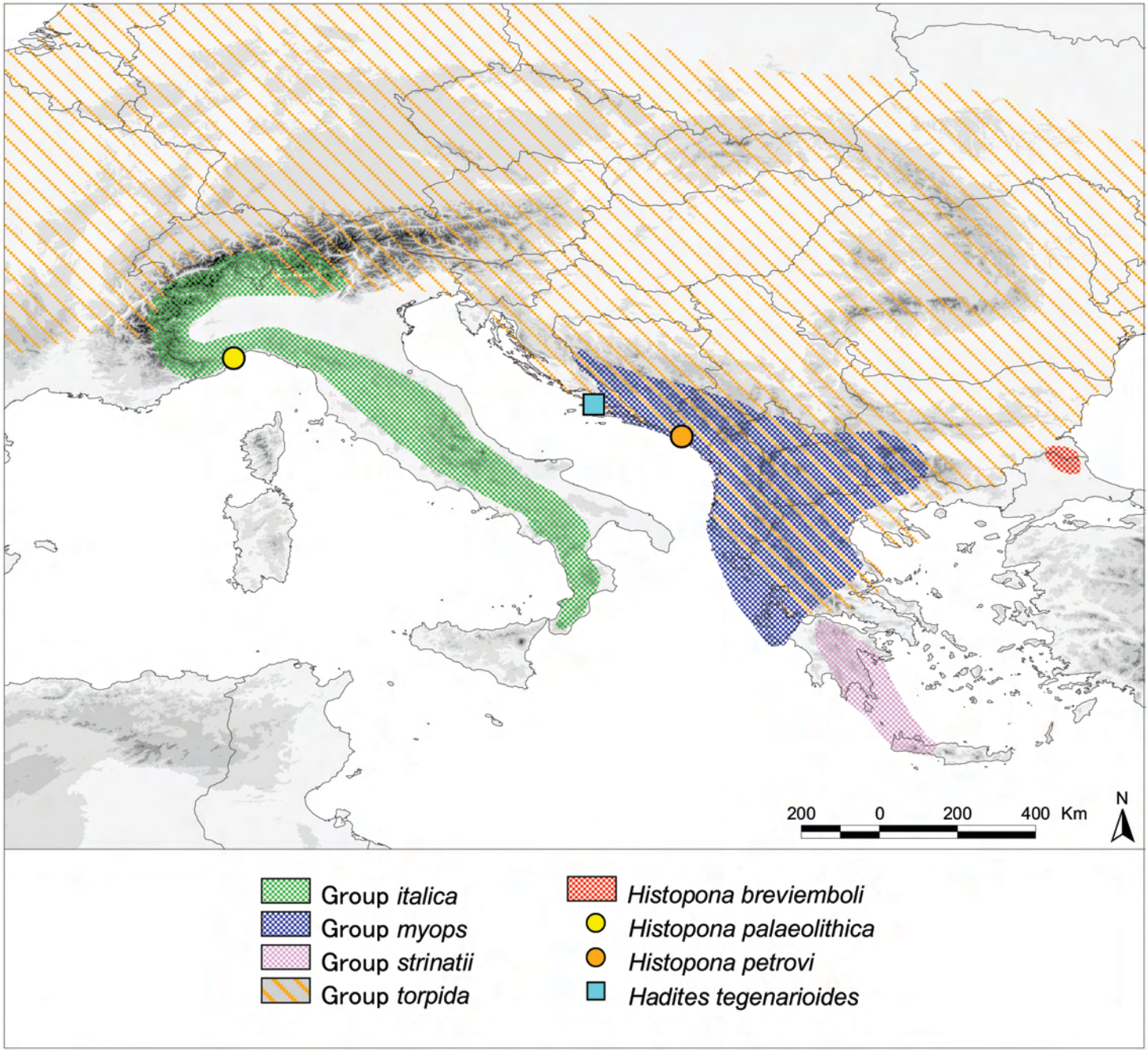


0.2 mm

(d)



0.2 mm


200
0
200
400 Km
N
Group italica
Group myops
Group strinatii
Group torpida
Histopona breviemboli
Histopona palaeolithica
Histopona petrovi
Hadites tegenarioides